DC:

SERIES CIRCUITS

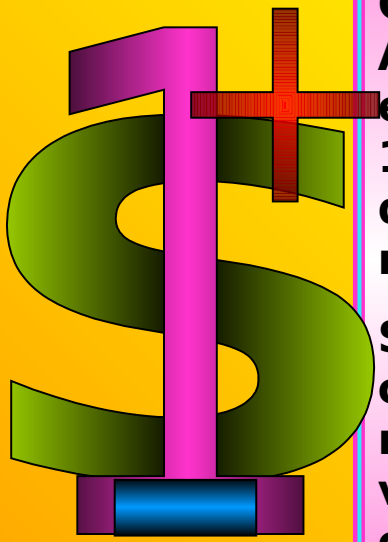
Unclassified:

2 Hour Conference W/2Hr. PE1

Safety & Environmental Impact: “LOW”

DC: Series Circuits

Terminal Learning Objective



ACTION: Calculate DC voltage, DC current, and resistance in a series circuit.

CONDITION: Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130A electronics trainer, digital Multimeter w/test leads, PC-130-6A and PC- 130-6B circuit cards, schematic diagrams, calculator, and official OMEMS reference materials.

STANDARD: Be able to identify series circuits characteristics, calculate voltage, current, and resistance values in a series circuit, properly measure voltage, current, and resistance in a series circuit, and compare to calculated values to the established standard of 7 correct answers out of 10 & 8 out of 10 for EOD.

DC: Series Circuits

Introduction

The Series circuit is the least complex of all electronic circuits. All ckts can be reduced down to a simple series Ckt.

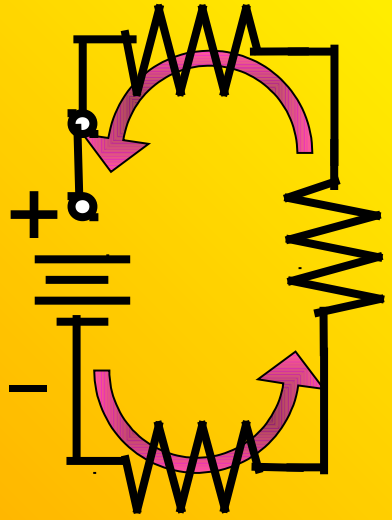
Ohms Law, Kirchhoff Law & Series ckts concepts are used to Find its operational parameters.

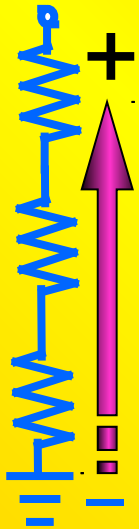
1 path

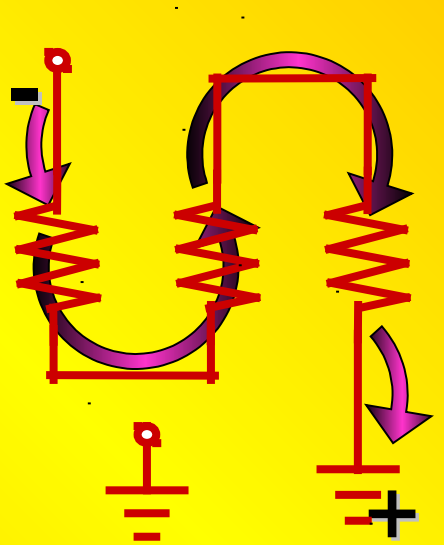
DC: Series Circuits

A Series Circuit is defined as Ckt that has only <u>one path for current</u> flow.

If one component burns open, the entire circuit ceases to operate.







Relationship

DC: Series Circuits

The relationship of Voltage, Current & Resistance that defines Ohms Law, will be observed in a Series Ckt.

E ↑ Constant → I ↑ Direct → R Remains

R ↑ Constant → I ↓ Inverse → E Remains

R ↑ → E_R ↑ Direct

RT

DC: Series Circuits & Resistance

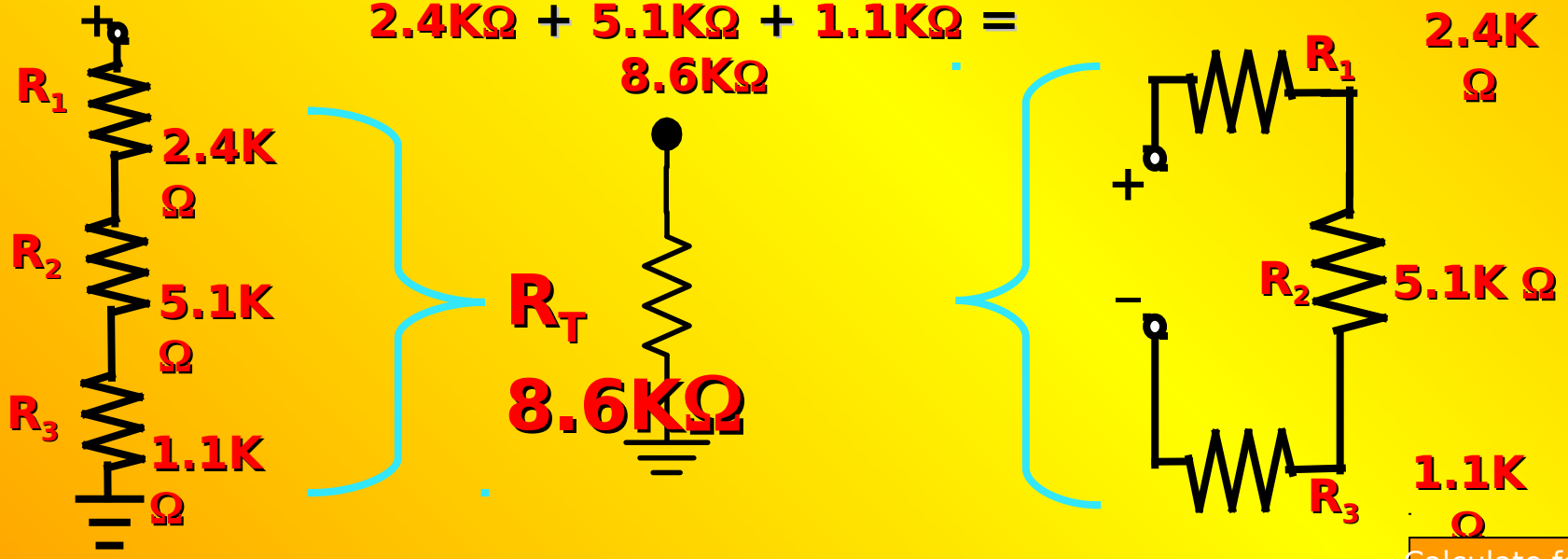
Resistance is the opposition to current flow.

Resistors in Series are Additive.

R_T is the sum of the individual resistors in a series Ckt.

$$R_1 + R_2 + R_3 = R_T$$

2.4KΩ + 5.1KΩ + 1.1KΩ = 8.6KΩ



Calculate for RT

DC: Series Circuits & Resistance

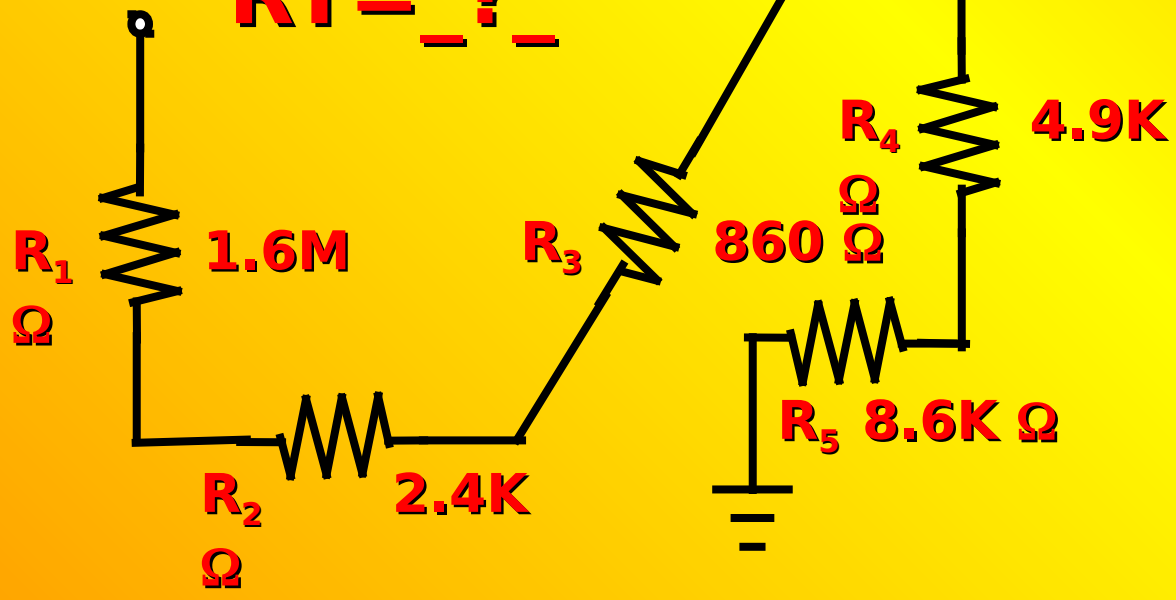
Calculate for Resistance Total

On The Calculator

1.6 M + 2.4 K + 860 + 4.9K + 8.6K =

1.6 EE 6 + 2.4 EE 3 + 860 + 4.9 EE 3 + 8.6 EE 3 =

RT= _?_



Long Hand

1600,000.0 Ω

2,400.0 Ω

860.0 Ω

\+ 4,900.0 Ω

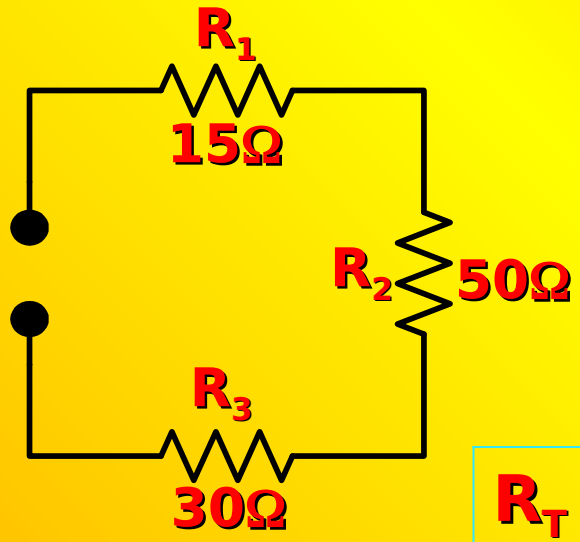
8,600.0 Ω

JOB: 1

DC: Series Circuits: Problem Sheets

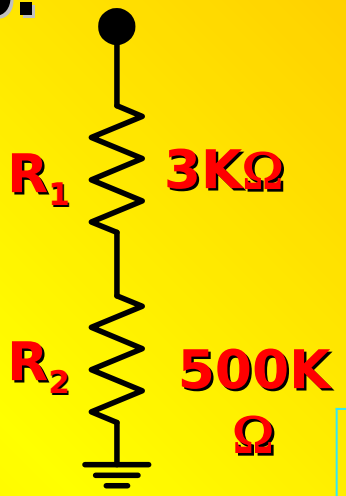
JOB 1: Calculate for R_T in the Following Ckts.

a.



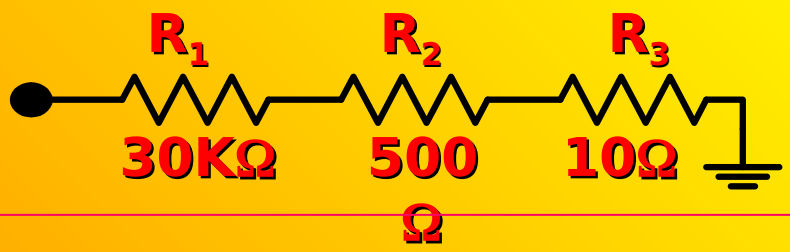
R_T = ___

b.



R_T = ____

c.



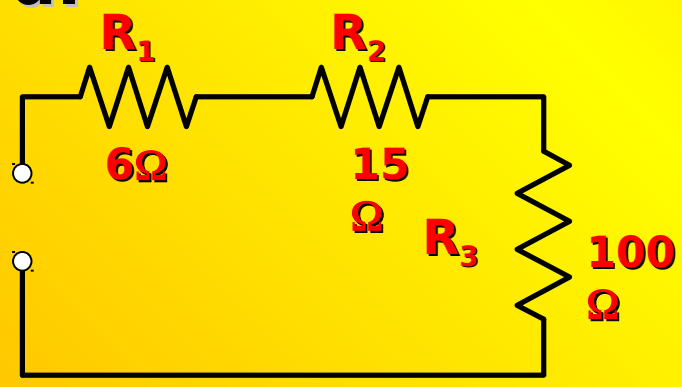
R_T = _____ ___

Answers; a-c

DC: Series Circuits: Problem Sheets

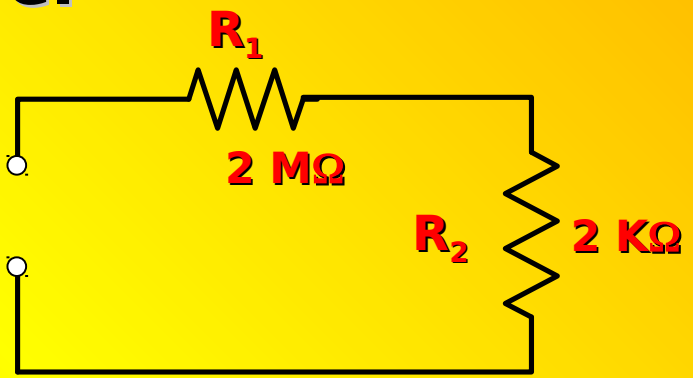
JOB 1: Calculate for R_T in the Following Ckts. {Cont}

d.



R_T = ____

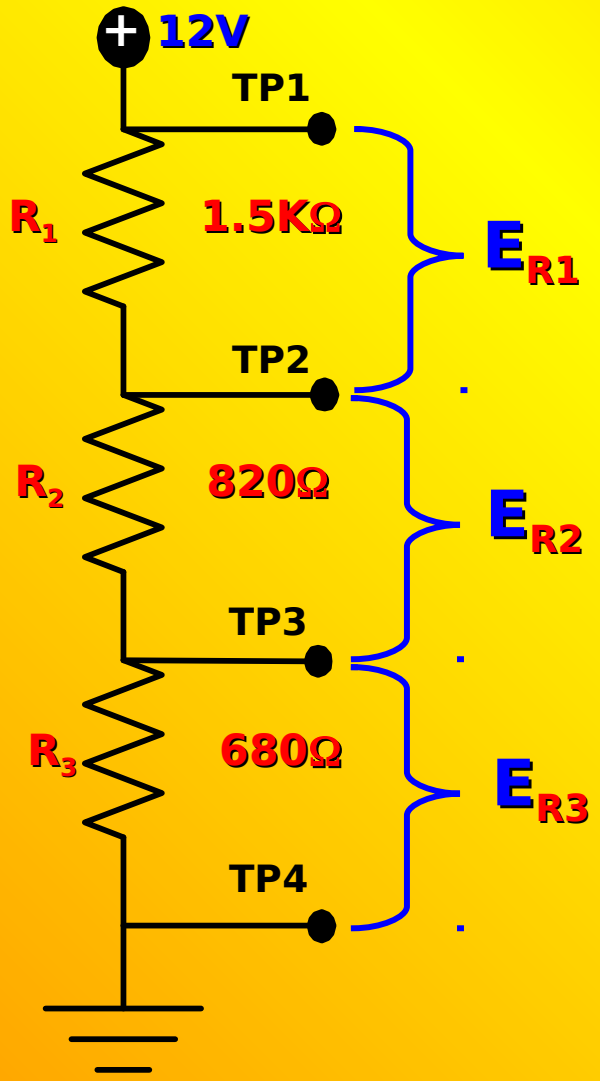
e.



R_T = _____

Answers; d, e

DC: Series Circuits & Voltage



Voltage is a product of Current & Resistance.

The R# in ER# describes which Resistor Resistance to use to calculate its voltage drop.

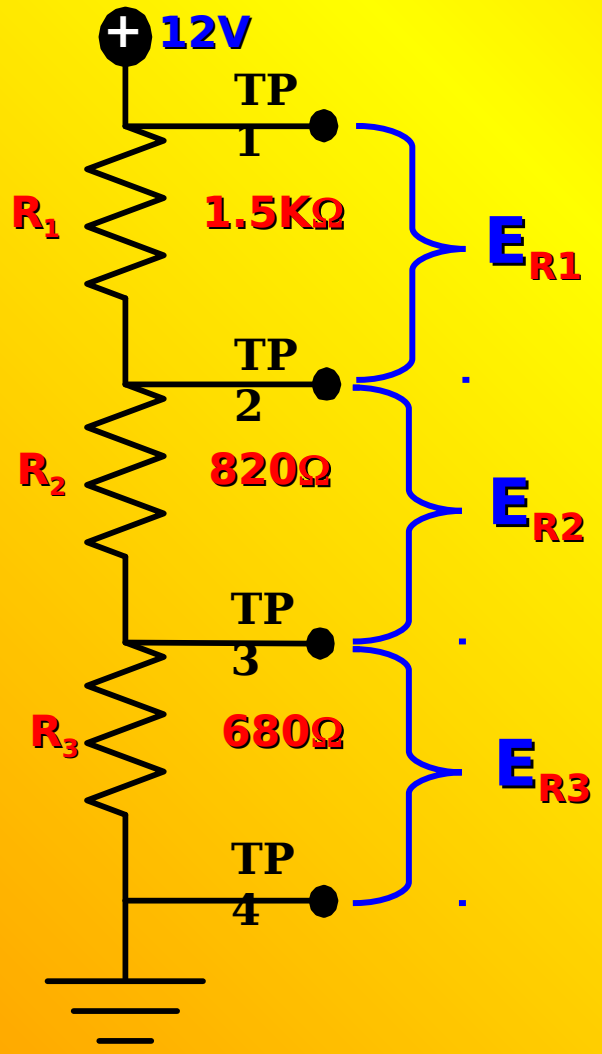
$$I_T \times R_{\#}$$

$$E_{R\#} \longrightarrow VDC$$

E Describes what we are looking for and the unit of Measure to use in the solution.

Challenge

DC: Series Circuits & Voltage Drops



Kirchhoff's Law

The Sum of the individual Voltage Drops is equal to the Voltage Applied.

Expressed Mathematically as: E_{R1}

$E_A + E_{R2} + E_{R3} = EA$

R_T ___ R1 + 2 + 3

I_T ___ $E_A \div R_T$

E_{R1} ___ $I_T \times R_1$

E_{R2} ___ $I_T \times R_2$

E_{R3} ___ $I_T \times R_3$

Answers

DC: Series Circuits & Voltage Drops

E_A = 12v

R_T = 3KΩ R1 + 2 + 3

I_T = 4mA $E_A \div R_T$

E_{R1} = 6v $I_T \times R_1$

E_{R2} = 3.28v $I_T \times R_2$

E_{R3} = 2.72v $I_T \times R_3$

Kirchhoff's Law Alternative

If the Sum of the individual Voltage Drops is equal to the Voltage Applied.

Then

$E_A - [E_{R1} + E_{R2}] = E_{R3}$

$E_A - [E_{R1} + E_{R3}] = E_{R2}$

$E_A - [E_{R2} + E_{R3}] = E_{R1}$

IF two or more Resistors are of the same value then they will have the same Voltage Drop.

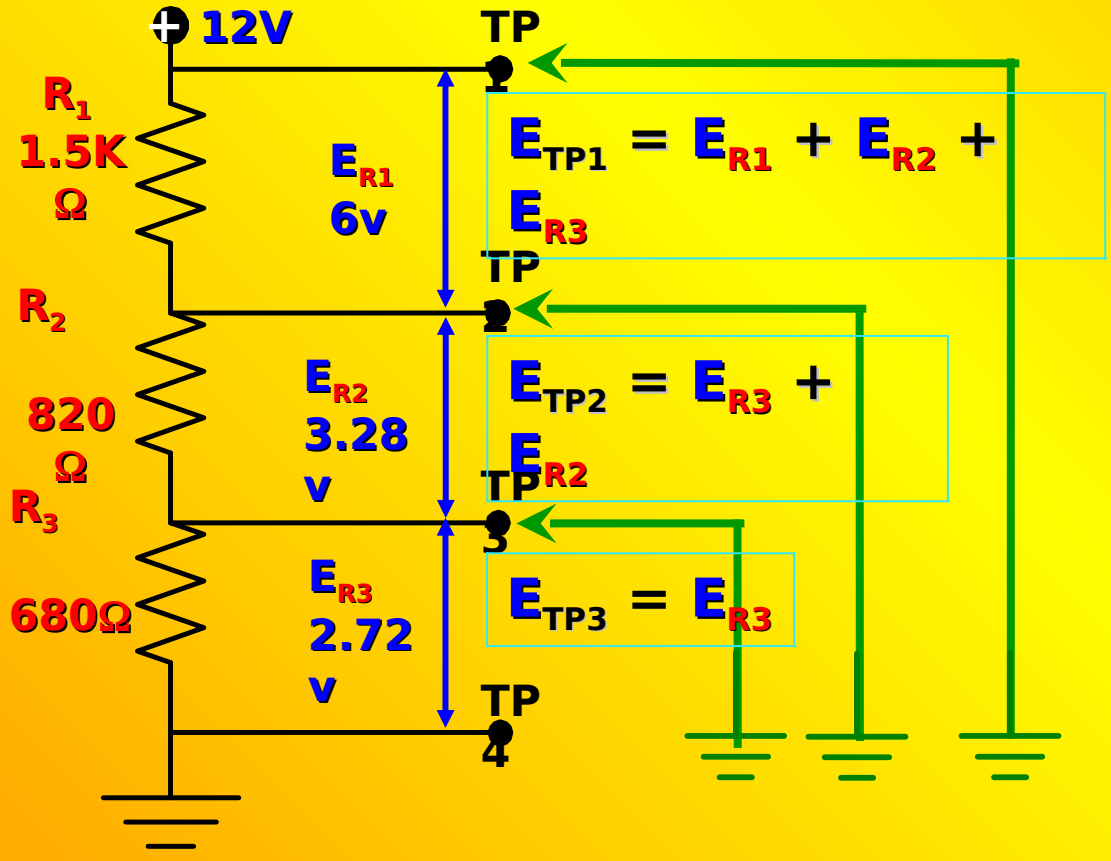
If all the resistors are of the same Value, & EA is known then EA ÷ Number of Resistors = $E_{R\#}$.

Voltage @ TP

DC: Series Circuits & Voltage @TP

Voltage at Test Points are made in reference to ground.

The voltages at TP are the Sum of the voltage Drops Between the TP & Gnd.



E_A 12V

R_T 3 KΩ

I_T 4 mA

E_{R1} 6V

E_{R2} 3.28V

E_{R3} 2.72V

E_{TP1} ___

E_{TP2} ___

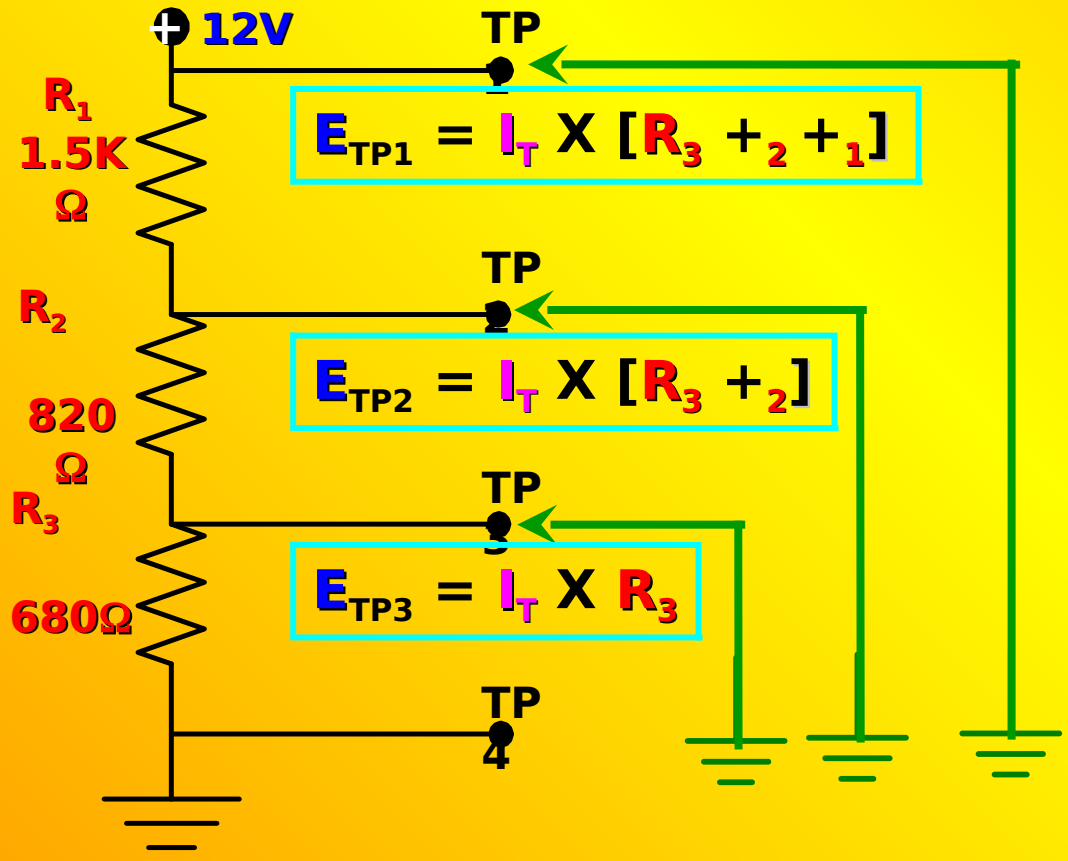
E_{TP3} ___

ETP Ω Law

DC: Series Circuits & Voltage @TP

Voltage at Test Points are made in reference to ground.

Using Ohms law; I_T X the [Sum of the Resistor { s }] between the TP & Gnd.



E_A 12V

R_T 3 KΩ

I_T 4 mA

E_{R1} 6V

E_{R2} 3.28V

E_{R3} 2.72V

E_{TP1} ____

E_{TP2} ____

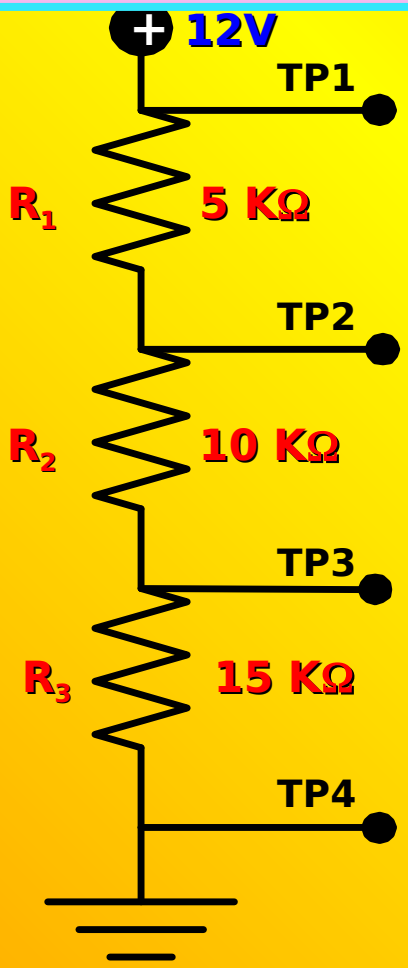
E_{TP3} ____

E_{TP4} ____

Challenge

DC: Series Circuits

Calculate for the Operating parameters



E_A = _____

R_T = _____

I_T = _____

E_{R1} = _____

E_{R2} = _____

E_{R3} = _____

E_{TP1} = _____

E_{TP2} = _____

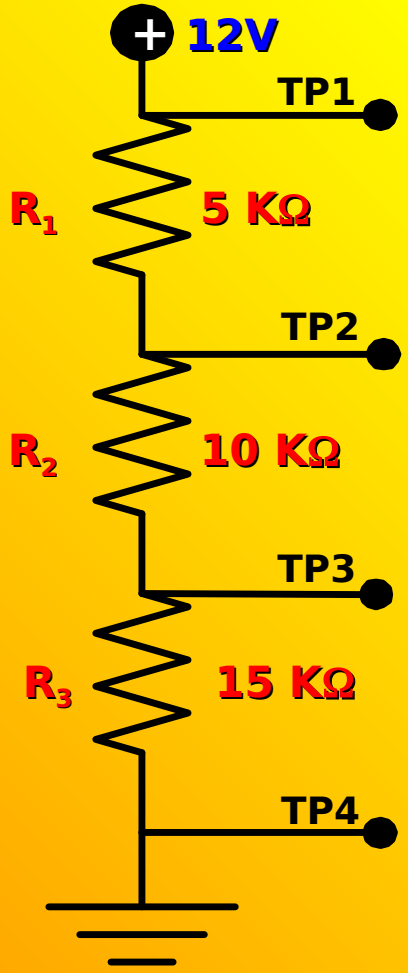
E_{TP3} = _____

E = _____

Answers

DC: Series Circuits

Calculate for the Operating parameters



Note:

R ⇑ E_R ⇓

Direct Relationship

E_A = 12 VDC

R_T = 30 KΩ

I_T = .4 mA

E_{R1} = 2 VDC

E_{R2} = 4 VDC

E_{R3} = 6 VDC

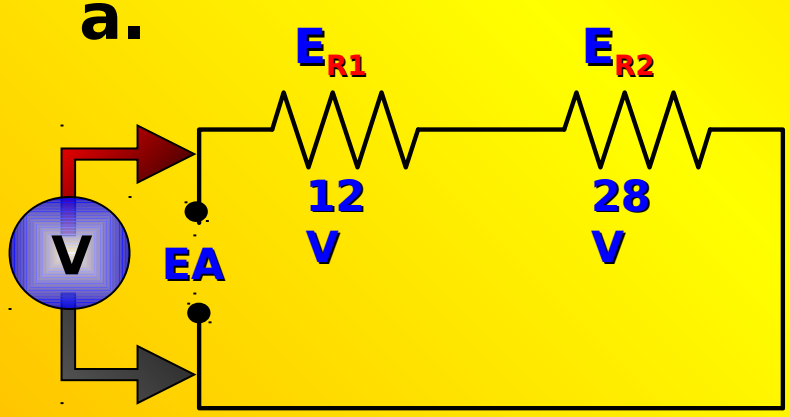
} = E_A

JOB: 2

DC: Series Circuits: Problem Sheets

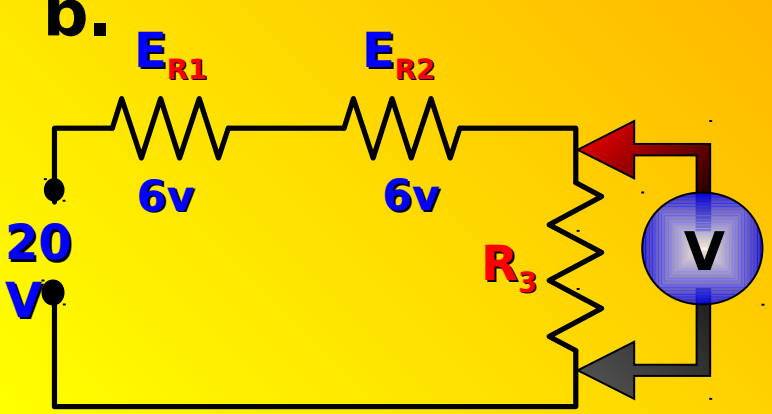
JOB 2: Calculate for Voltage in the Following Ckts.

a.



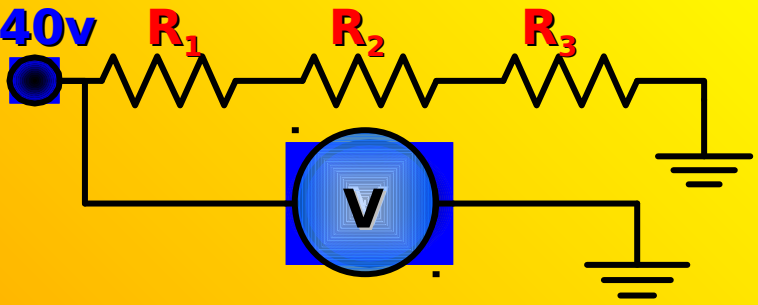
E_T = ___

b.



E_{R3} = ___

c.



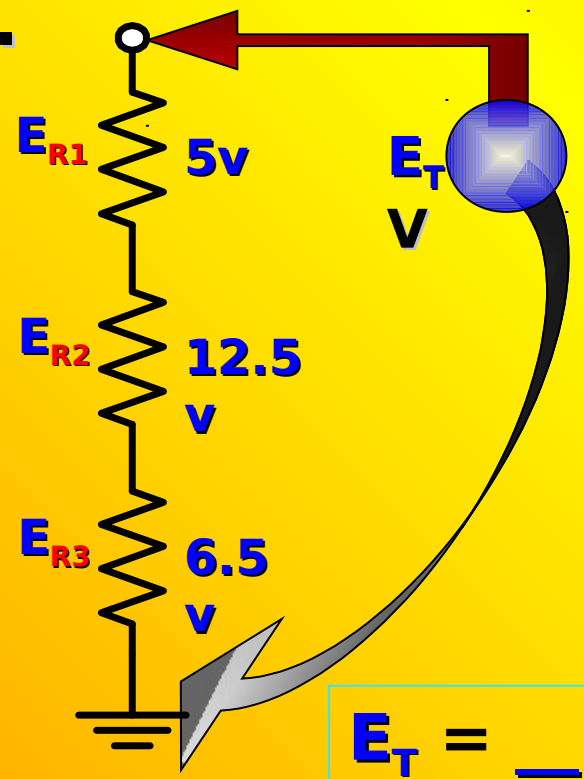
E_T = ___

Answers; a-c

DC: Series Circuits: Problem Sheets

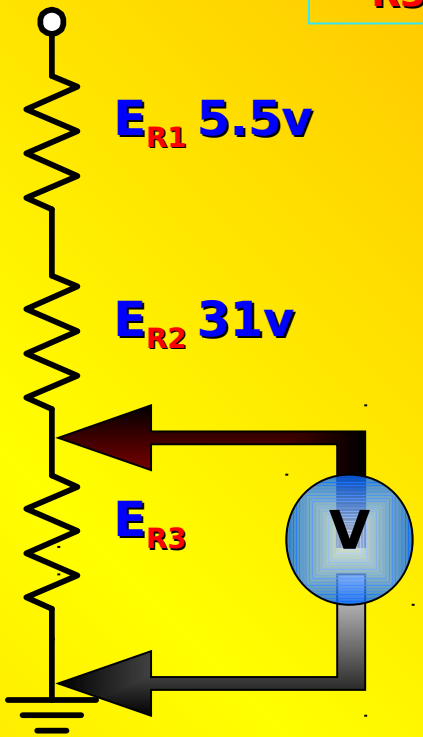
JOB 2: Calculate for Voltage in the Following Ckts.

d.



E_T = __

e.



E_{R3} = ____

Answers; d - e

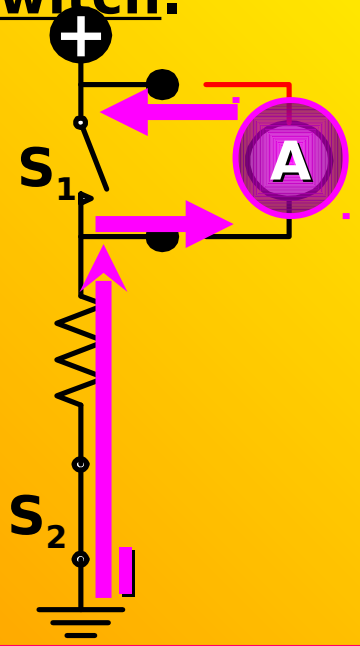
DC: Series Circuits & Current

Current in a series Ckt remains constant, or is the same.

Current is calculated by E_A over R_T.

Current flows from the most Negative potential to the most Positive.

Current must be measured in series, across an open switch.



By opening the Switch and placing the test leads across the switch, {Bracketing the SW between the test leads}, Current is provided a path thru the Amp Meter.

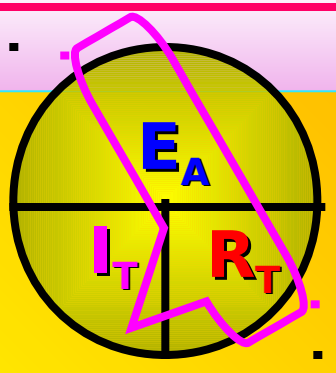
The meter is placed in series W/the Ckt.

Note: S2 remains closed, only the SW where the measurement is being taken is opened.

Challenge

DC: Series Circuits & Current

Calculate for I_T Using Ohms Law. $E_A \div R_T = I_T$



12V ÷ 5 Ω =

12V ÷ 5 KΩ =

12V ÷ 10 KΩ =

12V ÷ 30 KΩ = .0004 Amps

12V ÷ 30 KΩ =

The Calculator provides the answer in whole units of Amps

Roll the decimal 3 places Right for mA. .0004 = .4 mA

Note:

If there is KΩ of Resistance, there will be mA of Current.

Answers

DC: Series Circuits & Current

Calculate for I_T Using Ohms Law. $E_A \div R_T = I_T$

12v ÷ 5 Ω = 2.4 A

12v ÷ 5 KΩ = 2.4 mA

12v ÷ 10 KΩ = 1.2 mA

12v ÷ 20 KΩ = .6 mA

12v ÷ 30 KΩ = .4 mA

Note:

Whole units of Ω Whole units Amps

If there is KΩ of Resistance, there will be mA of Current.

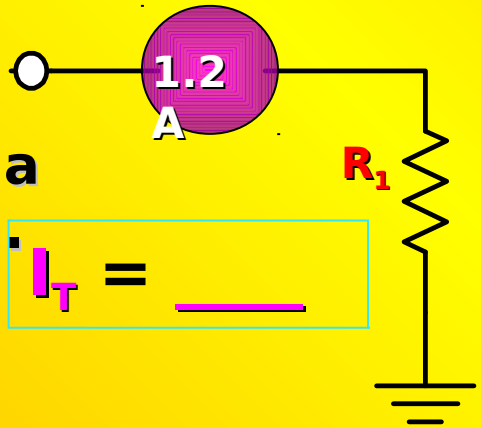
$R_T \propto \frac{1}{I_T}$ **Inverse Relationship**

JOB: 3

DC: Series Circuits: Problem Sheets

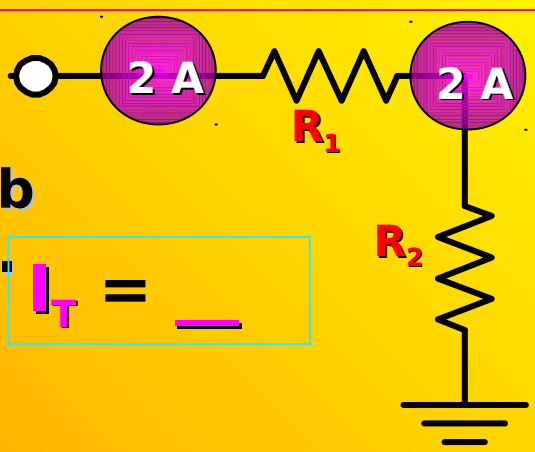
JOB 3: Calculate for Current in the Following Ckts.

a.



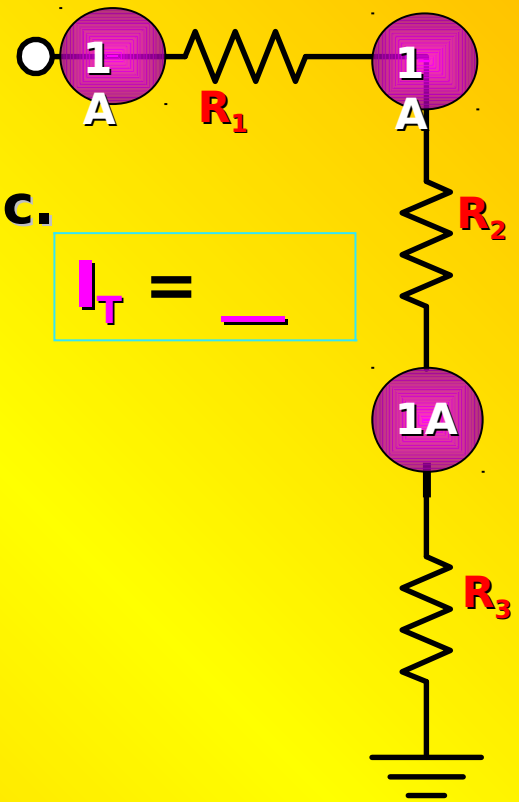
I_T = ____

b.



I_T = ____

c.



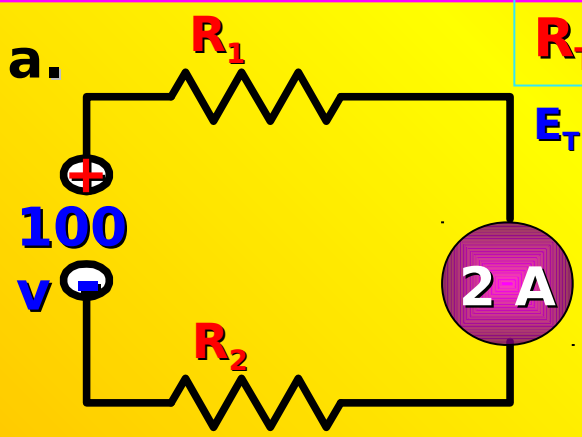
I_T = ____

Answers; a-c

DC: Series Circuits: Problem Sheets

JOB 4: Calculate for Current, Resistance, Voltage in the Following Ckts.

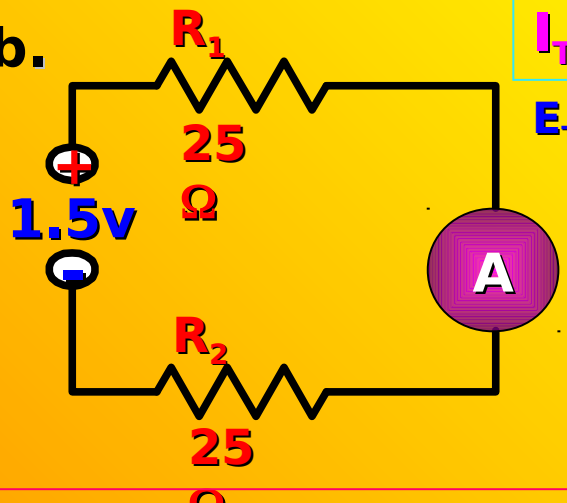
a.



R_T = ____

$E_T \div I_T = R_T$

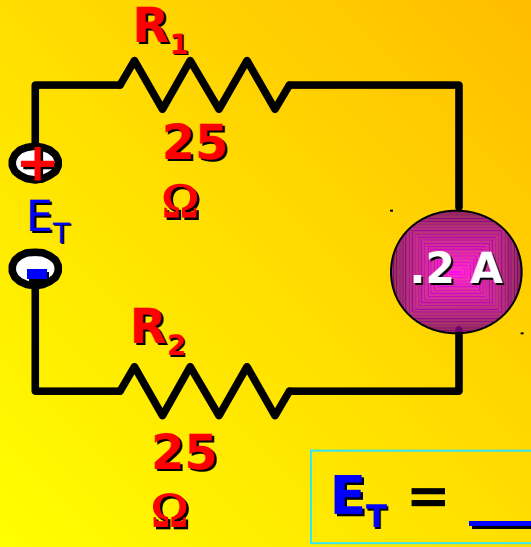
b.



I_T = ____

$E_T \div R_T = I_T$

c.



E_T = ____

I_T X R_T = E_T

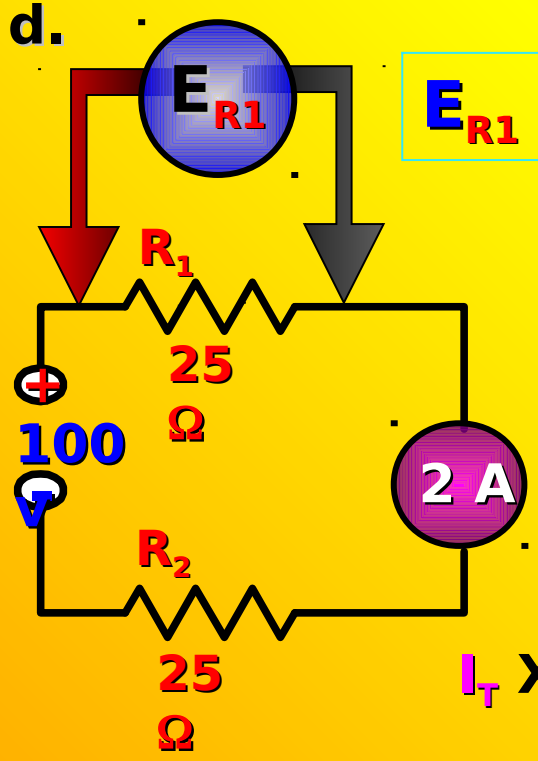
Note: E_T & E_A are the same

Answers; a-c

DC: Series Circuits: Problem Sheets

JOB 4: Calculate for Current, Resistance, Voltage in the Following Ckts.

d.



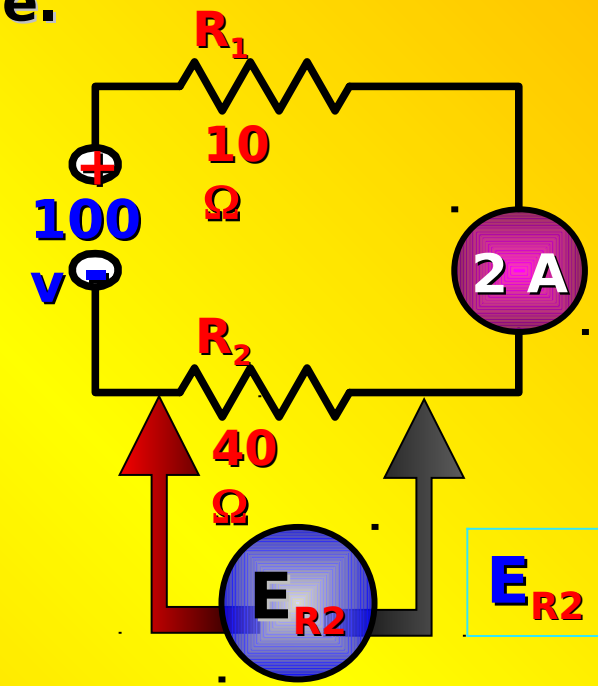
E_{R1} = ___

$I_T \times R_1 = E_{R1}$

or

$E_A \div 2 = E_{R1}$

e.



E_{R2} = ___

$I_T \times R_2 = E_{R2}$

Answers; d, e

DC: Series Circuits Concepts

SERIES Ckt:

ONE path for current to flow.

Resistance; is additive to = R_T. $R_T \Uparrow$, $I_T \Downarrow$

Current; is the same any place in the Ckt, I is always measured across an open Switch [Ckt].

$$I_{R1} = I_{R2} = I_{R\#} = I_T.$$

Voltage Drops; $E_{R\#}$, are additive to = E_A. $R \Uparrow$,

$E_{R\#} \Uparrow$ $E_{R1} + E_{R2} + E_{R\#} = E_A$.

Voltage @ TP; $E_{TP\#}$, is in Reference to Ground [Gnd].

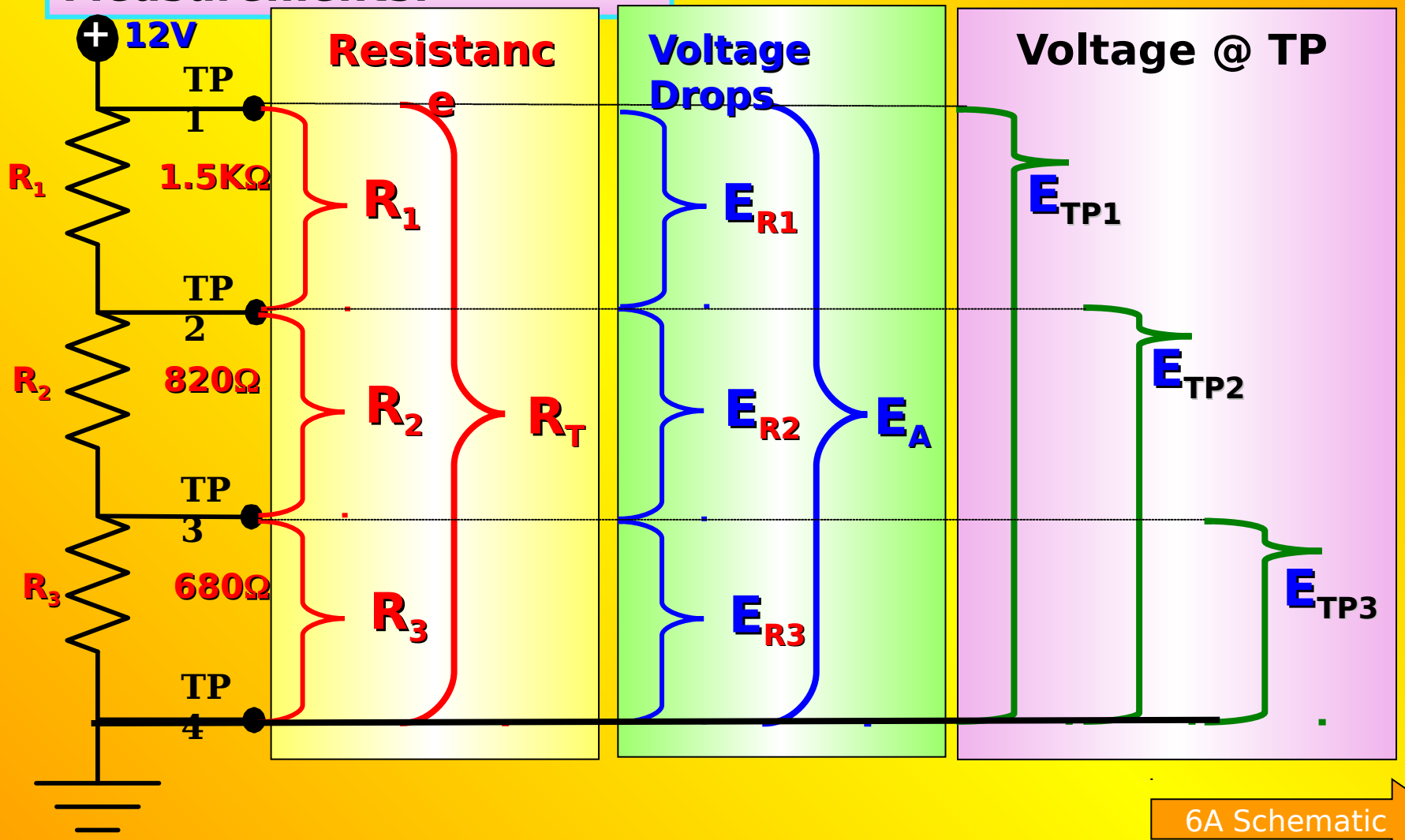
The Black test lead is placed at Gnd and kept at Gnd. The Voltage @ a TP is the Sum of the voltage drops of the Resistors between the Leads.

Applied Voltage; $E_A \Uparrow$, $I_T \Uparrow$

Taking Measurements

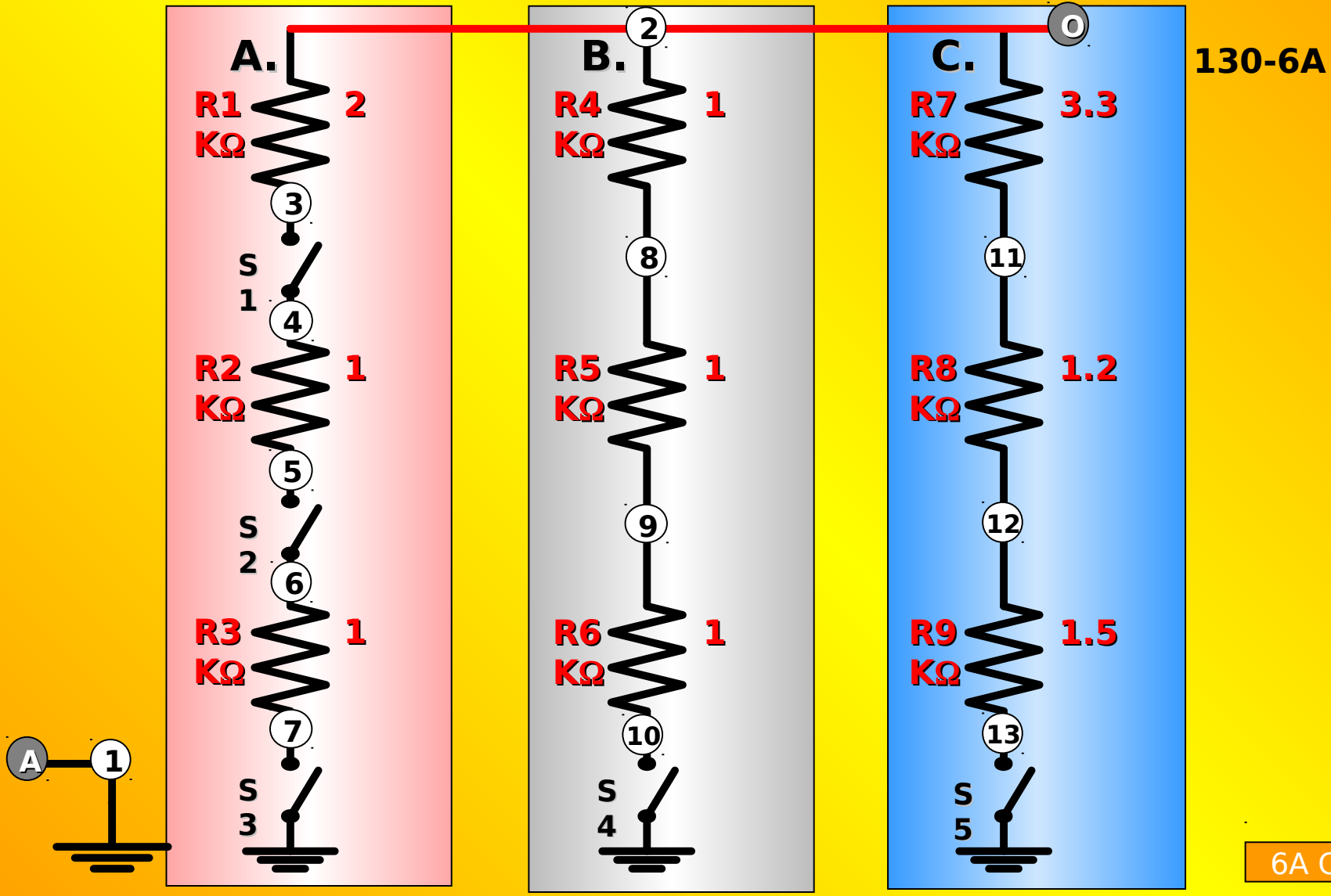
DC: Series Circuits Concepts

Taking the Measurements:



6A Schematic

DC: Series Circuits Concepts



6A Card

DC: Series Circuits

Lesson Test:

Standard: 10 Questions W/in 20 minutes 70% Minimum Accuracy. 80% for EOD.

Reference: Official OMEMS Training Aids